

## Smartphones Enabling Mobile Collaboration

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### Abstract

*Mobilization of the work-force is demanding new mobile and wireless technologies to facilitate contact between the growing number of mobile eWorkers and organizations. Smartphones incorporating mobile e-mail functionality enable instant access to e-mail boxes and company resources without complex synchronization. A study amongst sixteen German companies was conducted to elicit the influence of mobile e-mail on work-processes and communication. The empirical results indicate that mobile e-mail impacts on performance, whereas attitude towards technology influences perceived performance gains. According to our findings smartphones have the potential to improve and accelerate work processes through timely provision of information, enhanced reachability and the simplification of coordination processes. This study treats a present organizational issue related to increasing the productivity of the mobile workforce. The research expands the mobile e-mail literature by assessing the impact of mobile e-mail on performance and highlights the importance of attitude towards IT as an influencing variable.*

### 1. Introduction

In a globalized world with projects spanning borders and time zones, asynchronous e-mail makes up for a growing part of organizational communication and places the main communication medium for most enterprises [42]. Teleworking is getting ever more common in spatial decentralized organizations that are dependent on computer mediated communication (CMC) [31]. The on-going mobilization of the workforce - IDC predicts on 850 million mobile workers by 2009 [14] - calls for mobile communication and information systems. Mobile teleworking is not just limited to road warriors, like salespersons or consultants who mainly work from remote locations like airports or hotels, but also comprises the so called "corridor warriors", who spend most of the day away from

their desk [39]. Taking those figures into account the accelerated diffusion of smartphones is not surprising. Gartner Research [22] is predicting growth rates of 50% for 2007 with 93,6 million users worldwide. Usage is not limited to management level anymore and this democratization is promoting further growth [36]. The increasing user base will influence collaboration and communication of enterprises more than ever: It is expected that more than 80% of the knowledge workers will receive and create information on notebooks and smartphones by 2012 [22]. Although the number of mobile e-mail implementations is growing, generic concerns about cost and utility still place a major reason for not deploying a mobile e-mail solution [4]. Still, organizations are principally interested in the effects that information technologies (IT) exert on organizational and individual performance, justifying IT investment [45]. The objectives of this research were therefore to assess the impact of smartphones and the incorporated mobile e-mail functionality on the performance of employees and hence on firm performance. This complements existing literature on mobile e-mail that predominantly treats the effects on work-life balance [32, 48, 36] and communication patterns [50] with the impact on efficiency and performance [4, 44] being rather scarce. In order to generate insights on performance aspects of mobile e-mail, we followed a two step study design. During a pilot phase semi-structured interviews were conducted to elicit on the performance effects of mobile e-mail and to identify construct components. Then hypotheses were generated based on the findings of the pilot phase and literature in the field of IT and CMC research. These hypotheses were tested via a quantitative study using the attitude towards smartphones as independent variable. The independent variable was determined according to Doll's and Torkzadeh's [12] "system to value chain", which states that employees' attitudes towards ICT determine the usage of the system and hence its impact on individual and organizational performance.

## 2. Relevance

*"Advanced information technologies bring social structures which enable and constrain interaction to the workplace." [10], p. 125*

New communication technologies change enterprise structures and may have supporting but also impeding effects on work processes and the interaction of teams and organizations. According to DeSanctis and Poole [10] information technologies support business processes and the coordination between team members as well as enacting processes for interpersonal exchange. Researching the impact of mobile e-mail on performance, it is important to understand the technical features and their application as well as the organizational and social context in which they are used. The following sections discuss the dissemination of mobile work and the rising number of mobile eWorkers as well as the enabling technology of mobile e-mail embedded in smartphone devices.

### 2.1. The Broadening of Mobile Work

Teleworking as work being performed from remote locations using information and communication technologies [31; 35] has received much attention in literature. Teleworking adds further freedom to employees' work days by allowing flexible time and work management but it also demands higher organization skills from employees [37]. Teleworking is often referred to as work being performed at home or in satellite work centers [41]. This paper focuses on a third group of teleworkers, namely mobile workers. Perry et al. [38] define mobile work activities as "working at multiple (but stationary) locations, working in hotel rooms, on moving vehicles and in remote meeting rooms". Gareis et al. [18] distinguish between mobile workers, which do not necessarily rely on ICT, and "mobile eWorkers" as work-force in need of online connection to the company network or the internet. We shall adopt the term mobile eWorker for the following. The major reason for 92% of mobile eWorkers to connect to the enterprise server is e-mail, followed by the internet and the retrieval of company data mentioned by 75% [18]. Whereas the focus of mobile eWork was set so far on "road warriors" like salesmen and field forces, the "corridor warriors", being on the move within

the company premises and seldom found at their desk, are gaining attention [39].

Drivers for the mobilization of the work force can be located on economic, technological and socio-cultural level [18]. From an economic point of view the growth of extra- and intra-organizational transactions through the fragmentation of work and production processes has led to complex collaboration structures and employees spending more time working together with external parties [18]. Often those collaboration structures span nations and continents and therefore require asynchronous communication to transcend time lag. Gupta & Seshasai [23] describe the "24-Hour Knowledge Factory" in which virtual teams work in shifts using different time zones for continuous production. Competition and cost pressure in globalized business demand enhanced flexibility [2]. Companies implement mobile technologies like mobile e-mail for enhanced automation of work processes and improved provision of information for the mobile work force [6]. Customer orientation requires mobility and intensified extra-organizational collaboration [18]. On the technological side ICT developments like wireless technologies as boosters of space and time compression [27] constitute facilitators or even drivers of mobile work [2]. Socio-cultural drivers are dual income household calling for higher mobility or simply the preference of employees for more flexible work arrangements account for the socio-cultural factors [18].

### 2.2. Smartphones & Mobile E-Mail

Mobile e-mail, as mobile version of the accustomed e-mail, allows accessing messages via technical artifacts like PDAs, smartphones and BlackBerries almost independent from space and time. It is important to recognize that PDAs, cell phones and other mobile handheld devices are converging, offering a similar set of features. Smartphones are described as enterprise or prosumer focused devices, incorporating an operating system, capable of enterprise applications such as mobile e-mail, PIM synchronization as well as security and device management features [19]. E-Mail and its mobile form are used for multiple reasons, including the exchange of information or courtesies, the assignment of tasks and responsibilities as well as task management [7]. Whereas SMS and iMode are predominantly used in private context,

mobile e-mail has become accepted as a business application. Mobile e-mail facilitates applications like attachment handling and improved text and sign features, which surmount the functionalities of SMS and iMode [32]. Push-technology allows employees to check on their up-to-date e-mail inboxes, address books and calendars anytime and (nearly) anywhere without the need to perform complex synchronization processes [50]. Push-technology is also suitable for specific business applications like order and billing processes for field service.

In contrast to the broad adoption of mobile telephony the corporate reception of mobile e-mail has been hesitant [32, 4] and growth rates lacked far behind the expectations of vendors and consultants [4]. According to a survey of Berlecon Research [4] amongst German enterprises generic doubts about cost and utility of mobile e-mail were the major reason for not deploying the solution so far, nevertheless most of the respondents planned to implement mobile e-mail in near future. Gartner Research [20] expects that "by the end of 2008, at least 50 per cent of employees who today use corporate e-mail and spend 20 per cent of their time away from their working location will also get wireless access to e-mail." Gartner Research [20] also believes that mobile e-mail will be a commodity by 2010.

### 3. Theoretical Context & Hypotheses

This section reflects the literature research on the impact of mobile e-mail on work process and communication adding the findings from the qualitative pilot phase. Hypotheses were generated on the basis of the quoted literature and the interview results. The pilot phase is described in the following paragraph.

#### 3.1. Pilot Phase

During the pilot phase data were gathered through semi-structured telephone interviews with managers (CEO, CIO, Technology Managers) of the selected companies (refer to 4.1.) between December 2006 and February 2007. Mobile e-mail implementation usually follows a top-down approach, therefore management level employees were considered to have gained most expertise. Twenty managers were asked about the effects of mobile e-mail on collaboration, communication and performance

of the enterprise as well as about their individual perception of mobile e-mail and the effects on work-life balance. Interviews were recorded on mini-disc and transcribed. Interviews were analyzed following the Grounded Theory [23] approach. Statements were compared and examined for similarities and varieties and were coded accordingly. Theoretical sampling was applied for the determination of the sample size. Statements quoted in this paper were translated into English.

#### 3.2. Smartphones Impacting on Collaboration and Communication

Organizations increasingly face the need to work in a distributed manner, collaboratively and on the move [51]. Stough, Eom and Buckenmyer [43] notice, that "it is virtually impossible to avoid being a member of a team". Geographically dispersed and virtual teams are an integral part of doing business for many companies. Virtual teams are characterized by a common objective, the use of ICT to transcend time zones and distance as well as organizational boundaries [30]. Organizations install technical and organizational systems to allow mobile eWorkers to collaborate with partners and other employees to form a virtual team. Without ICT it would be impossible for mobile eWorkers to be reachable, stay in touch with team members or connect to the company server or internet for data retrieval. Wilson [51] defines collaboration as a "number of people engaged in interaction with each other, within a single series of episodes (meetings) to reach common goals". In contrast to classical teams mobile virtual teams rely on CMC, as face-to-face meetings are seldom and costly or even impossible. Kraut et al. [28] set forth, that collaboration is harder to accomplish in dispersed teams than in collocated teams due to less frequent communication and longer reply times. Because of time lags and language barriers, asynchronous e-mail is most frequently used in dispersed teams. Berry [5] points out that e-mail facilitates interactive and collaborative work making simultaneous communication with many parties possible. The fundamental role of e-mail in organizations and the increasing nomadic workday of employees state the reason for the spread of mobile e-mail [20].

Advantages as well as pitfalls derive from the usage of mobile e-mail in collaborative settings. Advantages are the possibility to review

and automatically archive communication [34], simplified team and task coordination [28], accelerated processes, improved reachability and the provision of up-to-date information [37]. These findings are inline with the results of the interviews as the reported major reasons for the implementation of smartphones were extended and improved reachability of mobile staff, shorter reaction times as well as the possibility to use dead times like queuing and taxi rides. Concerning work processes, more than half of the respondents assert an acceleration, whereas the focus is set on time-savings and improved communication.

The CEO of a consulting company:

*"Work processes advanced significantly, efficiency has improved, rapid communication is possible at all times, even on the train. Work time is obviously used more efficiently."*

Mobile e-mail also alters communication processes, people tend to be more explicit when writing, impeding misunderstanding [26]. In settings with cultural diversity mobile e-mail may overcome language barriers by giving more time for reflection before answering [5]. On the other hand e-mail is characterized as "poor" asynchronous communication [8] lacking social cognition that helps building trust in teams [28]. Being questioned about the influence of smartphones on communication, a quarter of the participants report a reduction of mobile telephone calls with a shift towards asynchronous mobile e-mail communication. The use of mobile e-mail is apparently dependent on the complexity and the topic of communication as well as on the relationship with the communication partner. Mobile e-mail is often used as it is rated less intrusive than calling a person, this is especially true for staff with customer contact as messages can be received without disturbing face-to-face meetings. Furthermore mobile e-mail is widely used for short informal communication with

closer colleagues and team members. The following statement illustrates the choice of communication medium.

The Technology Manager of a transport company:

*"On the move it is easier to write a short e-mail instead of calling, this is mostly limited to the closer colleagues, where messages can be informal. It is dependent on the person subgroup."*

Effective communication is an imperative for firm performance. According to Berry [5] effective communication "...means that intended recipients accurately receive messages in a time efficient manner". Weiss et al. [49] state that the productivity of knowledge workers would increase if organizations would facilitate the access to corporate knowledge. Information adds most to productivity if it is available when needed to perform a task. Smartphones foster the timely provision of information [4] and hence add to productivity. Mobile information technologies like mobile e-mail contribute to the productivity of employees [44, 48, 15].

Hammer's and Mangurian's [26] "Impact/Value Framework" (Figure 1.) illustrates the influence of information technologies like mobile e-mail on firm performance. Information and communication technologies foster the acceleration of business processes due to shorter reply times and faster provision of information [26]. These considerations lead us to propose that:

*H1: The use of smartphones accelerates work processes and hence impacts on performance.*

A recent survey amongst German enterprises shows that a major reason for the implementation of smartphones is the expected acceleration of work processes [4]. Berlecon Research [4] reports that smartphones promote process optimization. The availability of up-to-date calendar data for example allows the scheduling of meetings without prior involvement of the

<i>Value</i> <i>Impact</i>	<b>Efficiency</b>	<b>Value Effectiveness</b>	<b>Innovation</b>
<b>Time</b>	Accelerate Business Processes	Reduce Information Float	Create Service Excellence
<b>Geography</b>	Recapture Scale	Ensure Global Management Control	Penetrate New Markets
<b>Relationships</b>	Bypass Intermediaries	Replicate Scarce Knowledge	Build Umbilical Cords

Figure 1. Impact/Value Framework [26], p. 67

back-office. This implies time and cost savings due to the acceleration of coordination process and reduced workload for back-offices. However coordination efforts are shifted on the smartphone user. The immediate provision and coordination of information was also highlighted during the interviews.

The Support Manager of a consulting company:

*"Regarding the coordination process between secretariat and directors [...] scheduling meetings as well as the immediacy of the provision and coordination of information was something unexpected to us, the calendar functionality."*

Information technologies lead to efficiency gains as information is available in timely manner enabling organization wide consistency of management decisions and control and induce a broader knowledge base and intensified knowledge exchange in teams. Due to enhanced reachability and improved customer contact, perceived service quality is ameliorated. Reachability is of utmost importance in critical project phases. Torzadeh and Doll [45] assert that close interaction and the real-time flow of information add to perceived improvements in service quality. Hammer and Mangurian [26] state that information technologies strengthen the ties to business partners and endorse the creation of business excellence. During the interviews improved contact with customers and team members due to reachability and the timely provision of information was mentioned.

Decision theorists believe that information technologies help to overcome process losses that occur during team interaction [10]. During the interviews it was mentioned, that project escalations can be omitted or mitigated by the timely provision of information and the improved reachability of team members. The possibility to trace and store communication reduces information loss and accelerates team and decision processes. The statement of an CIO illustrates the effects on decision processes and the resulting performance gains.

The CIO of a consulting company:

*"Definitely yes, though I'm not able to express this [increased performance] in hard facts, but one can notice within projects, how decisions are promoted."*

Therefore we set forth that:

*H2: The use of smartphones improves collaborative work processes and hence impacts on performance.*

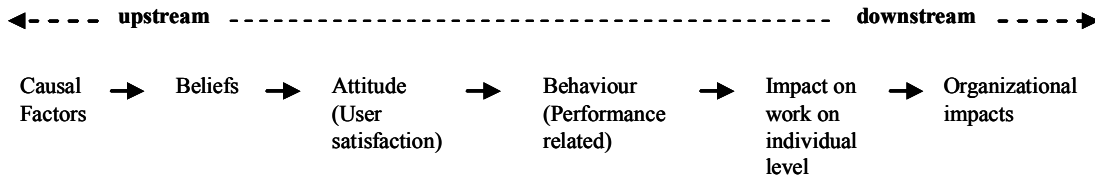
Regarding the effects of smartphones on firm performance more than half of the group stated that an increase in performance was obvious, though there were no installed control mechanisms for performance measurement. Companies reporting no influence on firm performance are characterized by low diffusion rates, with only few employees using smartphones. This leads us to the conclusion that companies with higher diffusion rates are more likely to benefit from performance gains. This reflects the fact that smartphones like most communication devices are network goods, where utility increases with the number of users [40].

## 4. Methods

### 4.1. Sample

The data of this study represents a survey of a sample of 16 small and large enterprises located in Germany. The sample consists out of firms using BlackBerry mobile e-mail service, partly drawn from the customer base of T-Mobile, Germany. Andersen [1] suggests, that the usage of computer mediated communication positively correlates with the dynamics of an enterprise's branch and its environment. Berlecon Research [4] as well as Turner et al. [46] suggest to recruit enterprises from early adopter branches like ICT, Consulting, Health Care & Pharmaceuticals for studies focusing on the use of new technologies to draw from gained experiences. To avoid hypothetical answers, enterprises were chosen which use smartphones for at least two years. Companies were recruited from early adopter branches like ICT, Consulting, Health Care, Transport and the public sector. The chosen enterprises employ a highly mobile work force including field staff, sales force and consultants spending most of their time at customer premises. The number of mobile e-mail users differs significantly between the enterprises, four companies report between 1-10 users, two companies are below one hundred users and ten companies report between 200 and 1500 users. Study design follows a two step approach taking advantage of the merits of triangulation. Between method triangulation was chosen to achieve a broader view on the topic [17] and to achieve advanced sophisticated rigor [9].

Drawing from the results of the qualitative research, an online questionnaire was designed.



**Figure 2. System to value chain [36], p. 328**

The structured questionnaire covers the following aspects: mobile e-mail usage patterns, effects of mobile e-mail on collaboration, communication and performance, effects on work-life balance, existence of communication rules regarding mobile e-mail. Effects were measured using statements rated via seven point Likert scales with the endpoints "do not agree at all" (=1) and "fully agree" (=7). The questionnaire was pretested with experts and adapted accordingly. The quantitative questionnaire was distributed in June 2007. A total of 78 employees responded.

#### 4.2. Measures

Measurement of firm performance related to IT impact follows different approaches. We have chosen a qualitative approach to operationalize firm performance as suggested financial figures like ROA, ROS [29] or firm profitability compared to competition [11] abstract away from surrounding factors and time lag between implementation and outcome of a new technology. According to literature firm performance is operationalized in terms of accelerated processes [4], process optimization [4], improved access to information [4, 26], increased productivity [44, 48], increased customer satisfaction [44, 26] and improved decision making [48].

Drawing on the literature review and the results of the qualitative pilot study, the variables for measuring performance impacts of mobile e-mail are operationalized. We have identified two different constructs that both add to firm performance. Process improvement comprising improved interaction and communication in collaborative settings as well as process acceleration. Indicators for process improvement are ameliorated customer interaction and decision making as well as the circumvention of project escalation. Process acceleration is operationalized by simplified appointment and team coordination processes, the acceleration of processes overall plus improved information, leading to faster reaction times. Table 1. shows

the respective statements belonging to the performance construct.

#### 4.3. Coding the Independent Variable

Doll and Torzadeh [12] argue that a concept of system use, identifying key-performance related usage behaviors, could provide independent variables to predict social and economic effects of IT on work. Torzkadeh's and Doll's [36] "system to value chain" is based on attitude-behavior theory showing that attitude is a proxy of behavior impacting on individual and organizational level. Taking the downstream perspective in this study we follow the system to value chain model shown in figure 2.

Downing [13] states that the link between system usage, user satisfaction and attitude is well documented in literature and determines user satisfaction as "one of the most important determinants of the success" of IT systems. Torzkadeh & Doll [36] give a literature overview on the operationalization of system use, which is predominantly measured by usage frequencies. Yet they set forth, that these measures should be considered carefully, as usage when required might be more appropriately viewed as compliance to company rules. Thus we questioned participants whether the use of a smartphone was expected by the enterprise. 77 per cent indicated that the use of a smartphone was mandatory. Taking these factors into account we decided to measure attitude towards smartphones as a proxy for usage, asking whether respondents like to work with their smartphone. The statement was measured on a 7-point Likert scale. We grouped responses into three buckets, people rejecting (group 1, n=8) or approving (group 3, n=53) the statement as well as people being indifferent (group 2, n=17).

#### 5. Analysis of the Quantitative Study

This section describes the statistical tests conducted on the data sample.

**Table 1. Summary of responses for the construct measures**

Performance Construct	Statement (seven-point Likert scale used)	Mean	SD
<b>Process Improvement</b>	Mobile e-mail devices support improved decision making. (PI1)	3.62	1.715
	Customer contact has improved thanks to mobile e-mail devices. (PI2)	4.71	1.691
	Project escalations can be circumvented thanks to real-time information available through mobile e-mail device. (PI3)	4.33	1.641
<b>Process Acceleration</b>	Appointment coordination has simplified thanks to mobile e-mail devices. (PAc1)	5.35	1.626
	Work processes have accelerated thanks to mobile e-mail devices. (PAc2)	5.45	1.526
	Thanks to my mobile e-mail device I'm better informed. (PAc3)	5.44	1.438
	My mobile e-mail device helps me to better coordinate team work. (PAc4)	4.95	1.643

**5.1. Descriptive Statistics**

About 76 per cent of the participants were male, the remaining 24 per cent female. Approximately 83 per cent of the participants hold an academic degree. 95 per cent of the respondents use BlackBerry another 5 per cent use a Nokia smartphone. The participants were spread across at least eight industries: consulting (35 per cent), banking & finance (3 per cent), IT & software (3 per cent), telecommunications (16 per cent), insurance (2 per cent), transport (5 per cent), public sector (18 per cent) and others (18 per cent). Regarding the performance impact questions, 75 per cent of the respondents say that they are better informed, 75 per cent experience work process acceleration, more than 60 per cent report simplified team coordination and approximately 60 per cent give account of improved customer contact. Table 1. shows the means and standard deviations for the respective questionnaire items.

**5.2. Construct Validity**

For measuring the reliability of the instrument Cronbach's alpha coefficient was used, Table 2. gives the computed values for the

**Table 2. Reliability coefficients**

Measure	Alpha
Process Improvement	0.775
Process Acceleration	0.734
Performance	0.809

constructs process improvement and process acceleration as well as for the overall performance construct. Eckstein [16] proposes that an alpha of 0.6 and higher is acceptable. Since alpha values are higher than 0.6 we conclude that the constructs are reliable.

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was computed to explore if factor analysis was suitable. We obtained an KMO value of 0.798 which is considered to be adequate [3]. Principal component analysis method with Varimax rotation was used. Table 3. shows the factor loadings. According to Hair et al. [25] variables with factor loadings above 0.5 are very significant, thus all variables are significant. The factors explain 62 per cent of the variance.

**Table 3. Principle components analysis with Varimax rotation**

Item	Factor 1	Factor 2
PI1	.391	.765
PI2	.153	.784
PI3	.151	.828
PAc1	.723	.205
PAc2	.721	.257
PAc3	.597	.311
PAc4	.809	.055

**5.3. Hypotheses Testing**

Kolmogorov-Smirnov test of normality was conducted to explore the distribution of the data. According to the test result, the sample does not

suffice the requirements of normal distribution. Hence we conducted non-parametric Kruskal-Wallis H-test. Table 4. depicts the results. Test results show that groups vary on 0.01 significance level for process acceleration (Pac) as well as performance (Perf), whereas process improvement (PI) is significant on 0.1 level. We see that H1 and H2 are supported.

**Table 4. Kruskal-Wallis H-Test**

	PI	Pac	Perf
Chi-Square	4.840	9.796	10.160
df	2	2	2
Asymp. Sig.	.089	.007	.006

To elicit on differences between the single groups we conducted Mann-Whitney U-test. For all constructs, groups 1 and 3 differ significantly. For process improvement there are no significant differences between groups 1 and 2 as well as between groups 2 and 3. For process acceleration groups 1 and 2 as well as 1 and 3 differ significantly, whereas groups 2 and 3 do not differ. The results in Table 5. also show that H1 and H2 are supported.

**Table 5. Mann-Whitney U-test between groups 1 and 3**

	PI 1 vs. 3	Pac 1 vs. 3	Perf 1 vs. 3
Mann-Whitney U	121.500	70.000	71.000
Wilcoxon W	157.500	106.000	107.000
Z	-1.942	-3.048	-3.020
Asymp. Sig.	.052	.002	.003

## 6. Implications and Conclusion

We have regarded performance as a multidimensional construct consisting of process improvement and process acceleration. The results of the statistical tests show that the instruments for measuring perceived performance are validated, attitude towards mobile e-mail influences the perceived performance, whereas employees with a positive attitude towards mobile e-mail perceive greater performance gains than employees with reservations about the technology.

Our study has research implications for the link between work-performance and attitude towards computer mediated communication. In

contrast to choosing usage as an independent variable we state that attitude should be considered as a proxy for usage in settings where usage of ICT is mandatory. Research results suggest that smartphones influence performance on individual and organizational level by accelerating and improving work processes. Communication with internal and external customers is ameliorated through extended reachability and the timely provision of information. Tangible benefits can be expected regarding customer satisfaction.

From a managerial point of view concerning cost and utility considerations this study gives insights on the performance effects and hence utility of mobile e-mail. Especially companies with a high quota of mobile staff will profit from the implementation of mobile e-mail. The study highlights the role of attitude towards mobile e-mail as a variable impacting on individual performance. This is especially true for companies with mandatory smartphone use with usage reflecting compliance to rules. Motivational aspects should be taken into account when implementing a mobile e-mail solution. Advantages and codes of conduct should be communicated to mitigate negative effects like the lack of respites and extended work hours.

The opportunity to access update information anytime and (nearly) anywhere as well as being reachable while on the move is a unique feature of smartphones. Mobile e-mail hence adds to the main purpose of teams, namely effectiveness [5]. The acceleration of work processes as well as the improvement of interaction processes have positive impact on performance. Whether mobile e-mail is a blessing or a curse for employees still remains an open point. Though not discussed within this paper the influence on the well-being of employees is not to be neglected as it is also relevant to collaborative processes and firm performance.

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